

Claims

[1] A map information processing apparatus comprising:

a position detecting means for detecting a position of the map information processing apparatus itself;

5 a map information storage means for storing map information including road information;

a map information acquiring means for acquiring the map information from said map information storage means;

10 a new road detecting means for determining whether or not a road corresponding to the position of the map information processing apparatus detected by said position detecting means is a new road which does not exist in the road information included in the map information acquired by said map information acquiring means;

15 a new road information storage means for storing new road information;

an intersecting judging means for identifying intersection points where the new road detected by said new road detecting means intersects either roads included in the map information acquired by said map information acquiring means or roads previously detected by said new road detecting means, other than start and end points of the new road;

20 a road update information generating means for generating new road information indicating the new road detected by said new road detecting means, and for generating road update information including information for updating said new road information stored in said new road information storage means and the road information included in the map information stored in said map information storage means; and

30 a road information updating means for updating the road

information included in the map information stored in said map information storage means, and road information included in the new road information stored in said new road information storage means based on the road update information generated by said road update information generating means, and for writing the new road information into said new road information storage means.

[2] The map information processing apparatus according to Claim 1, characterized in that said road update information generating means generates the road update information by defining the intersection points identified by said intersecting judging means as temporary intersections each of which is not determined to be either a grade crossing or a crossing with an overpass or underpass.

[3] The map information processing apparatus according to Claim 2, characterized in comprising an intersection determining means for determining whether each of temporary intersections included in the road information included in the map information stored in said map information storage means and those included in the new road information stored in said new road information storage means is a grade crossing or a crossing with an overpass or underpass.

[4] The map information processing apparatus according to Claim 3, characterized in that said map information processing apparatus comprises an intersection inquiring means for inquiring whether a temporary intersection is a grade crossing or a crossing with an overpass or underpass, and said intersection determining means determines that said temporary intersection is a grade crossing or a crossing with an overpass or underpass according to a response to the inquiry from said

intersection inquiring means.

[5] The map information processing apparatus according to Claim 4, characterized in that said map information processing apparatus comprises a route calculating means for calculating
5 a recommended route between two points, and, when the recommended route calculated by said route calculating means includes a temporary intersection and causes said map information processing apparatus to make a right or left turn at said temporary intersection, said intersection inquiring
10 means inquires whether said temporary intersection is a grade crossing or a crossing with an overpass or underpass.

[6] The map information processing apparatus according to Claim 4, characterized in that the intersection inquiring means inquires whether the temporary intersection is a grade crossing
15 or a crossing with an overpass or underpass when said map information processing apparatus stops its operation.

[7] The map information processing apparatus according to Claim 4, characterized in that the intersection inquiring means inquires whether the temporary intersection is a grade crossing
20 or a crossing with an overpass or underpass when said map information processing apparatus starts operating.

[8] The map information processing apparatus according to Claim 3, characterized in that said map information processing apparatus comprises a right or left turn detecting means for
25 detecting whether said map information processing apparatus itself has made a right or left turn at a temporary intersection, and the intersection determining means determines that the temporary intersection is a grade crossing when the right or left turn detecting means detects that said map information
30 processing apparatus has made a right or left turn at the

temporary intersection.

[9] The map information processing apparatus according to Claim 8, characterized in that the road update information generating means generates new road information including an amount of vertical movement of said map information processing apparatus at a time when traveling the new road, the position detecting means detects the position of said map information processing apparatus, the position including an amount of vertical movement of said map information processing apparatus, and the intersection determining means determines whether the temporary intersection is a grade crossing or a crossing with an overpass or underpass from both a history of change in the position of said map information processing apparatus detected by said position detecting means, the position including an amount of vertical movement of said map information processing apparatus, and information about change in an altitude of the new road which intersects an existing road at the temporary intersection when the right or left turn detecting means detects that said map information processing apparatus has made a right or left turn at the temporary intersection.

[10] The map information processing apparatus according to Claim 8, characterized in that said map information processing apparatus has a turn indicator for informing a third party of a right-hand or left-hand direction toward which said map information processing apparatus is going to make a turn, and the right or left turn detecting means detects that said map information processing apparatus has made a right or left turn based on information from said turn indicator.

[11] The map information processing apparatus according to Claim 9, characterized in that said map information processing

apparatus has a turn indicator for informing a third party of a right-hand or left-hand direction toward which said map information processing apparatus is going to make a turn, and the right or left turn detecting means detects that said map information processing apparatus has made a right or left turn
5 based on information from said turn indicator.

[12] The map information processing apparatus according to Claim 3, characterized in that the map information storage means stores the map information including the road information in
10 which altitude information is included, the position detecting means detects a three-dimensional position of said map information processing apparatus, the three-dimensional position including altitude information, the road update information generating means generates the road update
15 information including the altitude information detected by said position detecting means as the road update information about the temporary intersection, and the intersection determining means determines that the temporary intersection is a grade crossing when a difference at the temporary intersection
20 between altitude information about the new road detected by the new road detecting means and altitude information about a road indicated by the road information included in the map information stored in the map information storage means falls within a predetermined range, and determines that the temporary
25 intersection is a crossing with an overpass or underpass otherwise.

[13] The map information processing apparatus according to Claim 12, characterized in that the new road information storage means stores the new road information including altitude
30 information, and the intersection determining means determines

that the temporary intersection is a grade crossing when a difference at the temporary intersection between altitude information about the new road detected by the new road detecting means and altitude information about a road indicated
5 by the road information included in the map information stored in the map information storage means falls within a predetermined range, and determines that the temporary intersection is a crossing with an overpass or underpass otherwise.

10 [14] The map information processing apparatus according to Claim 1, characterized in that the map information storage means stores the map information including the road information in which altitude information is included, the position detecting means detects a three-dimensional position of said map
15 information processing apparatus, the three-dimensional position including altitude information, the road update information generating means generates the road update information including the altitude information detected by said position detecting means as the road update information about
20 the temporary intersection, and, even when detecting an intersection where the new road detected by said new road detecting means intersects either a road indicated by the road information included in the map information acquired by said map information acquiring means or a road previously detected
25 by said new road detecting means, the intersection determining means assumes that the detected intersection has not been detected if a difference at the intersection between altitude information about the new road and altitude information about the road which intersects the new road does not fall within a
30 predetermined range.

[15] The map information processing apparatus according to Claim 3, characterized in that said map information processing apparatus comprises a velocity detecting means for detecting a velocity of said map information processing apparatus, and
5 a travel-history-information storage means for storing travel history information including a history of both the position of said map information processing apparatus detected by the position detecting means and the velocity of said map information processing apparatus which is detected by said
10 velocity detecting means when the position of said map information processing apparatus is detected, and the intersection determining means retrieves travel information about travel of said map information processing apparatus when it enters a temporary intersection from said travel history
15 information stored in said travel-history-information storage means, and determines that said temporary intersection is a grade crossing when the retrieved travel information indicates that said map information processing apparatus was held at a velocity of zero within a predetermined area extending from the
20 temporary intersection for a predetermined time period.

[16] The map information processing apparatus according to Claim 3, characterized in that the intersection determining means determines that a temporary intersection is a grade crossing when detecting that said map information processing
25 apparatus has moved from a new road stored in the new road information storage means to a road indicated by the road information included in the map information stored in the map information storage means at the temporary intersection, based on the position of said map information processing apparatus
30 detected by the position detecting means.

[17] The map information processing apparatus according to Claim 3, characterized in that the intersection determining means determines that a temporary intersection is a grade crossing when detecting that said map information processing apparatus has moved from a road indicated by the road information included in the map information stored in the map information storage means at the temporary intersection to a new road stored in the new road information storage means, based on the position of said map information processing apparatus detected by the position detecting means.

[18] The map information processing apparatus according to Claim 16, characterized in that the intersection determining means determines that a temporary intersection is a grade crossing when detecting that said map information processing apparatus has moved from a road indicated by the road information included in the map information stored in the map information storage means at the temporary intersection to a new road stored in the new road information storage means, based on the position of said map information processing apparatus detected by the position detecting means.

[19] The map information processing apparatus according to Claim 3, characterized in that the intersection determining means determines that a temporary intersection is a grade crossing when detecting that said map information processing apparatus has moved from a new road stored in the new road information storage means to another new road stored in the new road information storage means at the temporary intersection, based on the position of said map information processing apparatus detected by the position detecting means.

[20] The map information processing apparatus according to

Claim 16, characterized in that the intersection determining means determines that a temporary intersection is a grade crossing when detecting that said map information processing apparatus has moved from a new road stored in the new road information storage means to another new road stored in the new road information storage means at the temporary intersection, based on the position of said map information processing apparatus detected by the position detecting means.

[21] The map information processing apparatus according to Claim 17, characterized in that the intersection determining means determines that a temporary intersection is a grade crossing when detecting that said map information processing apparatus has moved from a new road stored in the new road information storage means to another new road stored in the new road information storage means at the temporary intersection, based on the position of said map information processing apparatus detected by the position detecting means.

[22] The map information processing apparatus according to Claim 3, characterized in that said map information processing apparatus comprises an image capturing device for capturing an image of surroundings of said map information processing apparatus, and an image signal processing means for processing an image signal indicating the image captured by said image capturing device, and the intersection determining means determines whether a temporary intersection is a grade crossing or a crossing with an overpass or underpass from the image signal processed by said image signal processing means.

[23] The map information processing apparatus according to Claim 1, characterized in that said map information processing apparatus comprises an image capturing device for capturing an

image of surroundings of said map information processing apparatus, and, even when detecting an intersection point where a new road detected by said new road detecting means intersects either a road indicated by the road information included in the map information acquired by said map information acquiring means or a road previously detected by said new road detecting means, the intersection determining means assumes that the detected intersection point has not been detected if determining that the intersection point is a crossing with an overpass or underpass from the image captured by said image capturing device.

[24] The map information processing apparatus according to Claim 3, characterized in that said map information processing apparatus has a toll road travel determining means for determining whether or not said map information acquiring means is traveling a toll road, and, if said toll road run determining means determines that said map information acquiring means is traveling a toll road when said map information acquiring means arrives at a temporary intersection, the intersection determining means determines that said temporary intersection is a crossing with an overpass or underpass.

[25] The map information processing apparatus according to Claim 1, characterized in that said map information processing apparatus has a toll road travel determining means for determining whether or not said map information acquiring means is traveling a toll road, and, even when detecting an intersection point where a new road detected by said new road detecting means intersects either a road indicated by the road information included in the map information acquired by said map information acquiring means or a road previously detected

by said new road detecting means, the intersection determining means assumes that the detected intersection point has not been detected if said toll road travel determining means determines that said map information acquiring means is traveling a toll road.

[26] The map information processing apparatus according to Claim 3, characterized in that said map information processing apparatus has a temporary intersection road type determining means for determining a type of a road which intersects at a temporary intersection, and, when said temporary intersection road type determining means determines that at least one of roads which intersect at a temporary intersection included in a new road stored in the new road information storage means is a highway, the intersection determining means determines that the temporary intersection is a crossing with an overpass or underpass.

[27] The map information processing apparatus according to Claim 1, characterized in that said map information processing apparatus has a temporary intersection road type determining means for determining a type of a road which intersects at a temporary intersection, and, even when detecting an intersection point where a new road detected by said new road detecting means intersects either a road indicated by the road information included in the map information acquired by said map information acquiring means or a road previously detected by said new road detecting means, the intersection determining means assumes that the detected intersection point has not been detected if said temporary intersection road type determining means determines that the road which intersects the new road at the intersection point is a highway.

[28] The map information processing apparatus according to Claim 3, characterized in that said map information processing apparatus has an underpass travel detecting means for detecting an elevated structure under which a road which said map information processing apparatus is traveling is located, and, when said underpass travel detecting means detects an elevated structure when said map information processing apparatus is passing through a temporary intersection, the intersection determining means determines that said temporary intersection is a crossing with an overpass or underpass.

[29] The map information processing apparatus according to Claim 1, characterized in that said map information processing apparatus has an underpass travel detecting means for detecting an elevated structure under which a road which said map information processing apparatus is traveling is located, and, even when detecting an intersection point where a new road detected by said new road detecting means intersects either a road indicated by the road information included in the map information acquired by said map information acquiring means or a road previously detected by said new road detecting means, the intersection determining means assumes that the detected intersection point has not been detected when said underpass travel detecting means detects an elevated structure.

[30] The map information processing apparatus according to Claim 28, characterized in that said map information processing apparatus has an illuminance measurement means for measuring an amount of light applied to said map information processing apparatus, and the underpass travel detecting means detects an elevated structure by detecting a change in the amount of light measured by said illuminance measurement means.

[31] The map information processing apparatus according to Claim 29, characterized in that said map information processing apparatus has an illuminance measurement means for measuring an amount of light applied to said map information processing apparatus, and the underpass travel detecting means detects an elevated structure by detecting a change in the amount of light measured by said illuminance measurement means.

[32] The map information processing apparatus according to Claim 28, characterized in that said map information processing apparatus has a capturable satellite detecting means for detecting satellites from which said map information processing apparatus can capture signals, and the underpass travel detecting means detects an elevated structure by detecting a change in information about satellites in a direction of zenith which are detected by said capturable satellite detecting means.

[33] The map information processing apparatus according to Claim 29, characterized in that said map information processing apparatus comprises a capturable satellite detecting means for detecting satellites from which said map information processing apparatus can capture signals, and the underpass travel detecting means detects an elevated structure by detecting a change in information about satellites in a direction of zenith which are detected by said capturable satellite detecting means.

[34] The map information processing apparatus according to Claim 3, characterized in that said map information processing apparatus has a receiving means for receiving information indicating whether a temporary intersection is a grade crossing or a crossing with an overpass or underpass from outside said

map information processing apparatus, and the intersection determining means determines whether a temporary intersection included in the new road information stored in the new road information storage means is a grade crossing or a crossing with an overpass or underpass based on the information received by said receiving means.

[35] The map information processing apparatus according to Claim 3, characterized in that said map information processing apparatus comprises: an underpass travel detecting means for, while said map information processing apparatus is traveling either a road indicated by the road information included in the map information stored in the map information storage means, or a road indicated by the new road information stored in the new road information storage means, detecting whether an elevated structure is crossing above the road which said map information processing apparatus is traveling; an unregistered underpass travel determining means for, when the elevated structure detected by said underpass travel detecting means matches with neither any structure contained in the map information stored in said map information storage means nor any road indicated by the new road information stored in said new road information storage means, determining that the road which said map information processing apparatus is traveling is an underpass which is located under the unregistered elevated structure, and for generating unregistered underpass information including position information on a position of a point under the unregistered elevated structure; and an unregistered underpass information storage means for storing the unregistered underpass information generated by said unregistered underpass travel determining means, and

characterized in that when the unregistered underpass information corresponding to the temporary intersection is stored in said unregistered underpass information storage means, the intersection determining means determines that the
5 temporary intersection is a crossing with an overpass or underpass.

[36] The map information processing apparatus according to Claim 1, characterized in that said map information processing apparatus comprises: an underpass travel detecting means for,
10 while said map information processing apparatus is traveling either a road indicated by the road information included in the map information stored in the map information storage means, or a road indicated by the new road information stored in the new road information storage means, detecting whether an
15 elevated structure is crossing above the road which said map information processing apparatus is traveling; an unregistered underpass travel determining means for, when the elevated structure detected by said underpass travel detecting means matches with neither any structure contained in the map
20 information stored in said map information storage means nor any road indicated by the new road information stored in said new road information storage means, determining that the road which said map information processing apparatus is traveling is an underpass which is located under the unregistered elevated
25 structure, and for generating unregistered underpass information including position information on a position of a point under the unregistered elevated structure; and an unregistered underpass information storage means for storing the unregistered underpass information generated by said
30 unregistered underpass travel determining means, and

characterized in that even when detecting an intersection point where a new road detected by said new road detecting means intersects either a road indicated by the road information included in the map information acquired by said map information
5 acquiring means or a road previously detected by said new road detecting means, the intersection determining means assumes that the detected intersection point has not been detected when corresponding unregistered underpass information is stored in said unregistered underpass information storage means.

10 [37] The map information processing apparatus according to Claim 1, characterized in that said map information processing apparatus comprises a map area movement detecting means for detecting whether or not said map information processing apparatus is moving from a map area to another map area, and
15 the map information storage means stores the map information which is divided into plural pieces of map information about a plurality of map areas, when said map area movement detecting means detects that said map information processing apparatus is moving from a map area to another map area, the new road
20 detecting means records a current position of said map information processing apparatus, as a map area boundary point, into a travel history, and the road update information generating means divides the new road detected by said new road detecting means into two parts at said map area boundary point
25 to generate road update information for each of the map areas.

[38] The map information processing apparatus according to Claim 1, characterized in that said map information processing apparatus comprises an output means for outputting the map information stored in the map information storage means and the
30 new road information stored in the new road information storage

means, and, when outputting either the road information included in the map information stored in said map information storage means or the new road information stored in said new road information storage means, said output means shows a
5 temporary intersection included in either said road information or said new road information in a form different from that in which a grade crossing or a crossing with an overpass or underpass is shown.

[39] The map information processing apparatus according to
10 Claim 1, characterized in that said map information processing apparatus comprises an output means for outputting the map information stored in the map information storage means and the new road information stored in the new road information storage means, and said output means outputs the new road information
15 stored in said new road information storage means in a form different from that in which the road information included in the map information stored in said map information storage means is output.

[40] The map information processing apparatus according to
20 Claim 38, characterized in that said output means outputs the new road information stored in said new road information storage means in a form different from that in which the road information included in the map information stored in said map information storage means is output.